impact BIOENERGY!

Idaho National Laboratory • **BIOMASS FEEDSTOCK NATIONAL USER FACILITY**

Welcome to the Summer 2016 issue of Impact Bioenergy. This issue is dedicated to the Bioenergy Feedstock Library, a living archive of biomass data and samples designed to help overcome challenges associated with biomass variability. Variability is perhaps the most important challenge facing the bioenergy industry. As such, we believe the Bioenergy Feedstock Library is poised to play an important role in the successful integration of biofuels into the nation's energy portfolio.

- Kevin Kenney, BFNUF director

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THE VARIABILITY PROBLEM

Compared with other energy industries, bioenergy producers face the difficult and costly challenge of producing consistent feedstocks from diverse and variable biomass materials. Without consistent feedstocks, industry faces a host of challenges: clogged conveyors, microbial degradation, incomplete digestion, obstructed grinder screens… the list goes on and on.

Biomass variability is fundamental and unavoidable. Different species — corn versus pine, for example — are, of course, inherently different. But even samples of the same crop harvested from the same field may show divergent characteristics, as do different anatomical fractions of the same plant.

For example, moisture content has perhaps the most significant impact on herbaceous feedstock performance from harvest to conversion.

Moisture variability starts in the field. Harvest time, soil type, harvest method and weather all impact the moisture content of biomass. Higher moisture contents increases transportation costs and support microbial and fungal growth that leads to degradation in storage.

Storage itself can increase moisture variability. Moisture migration during long-term storage may result in a 20 percent difference in moisture content between different regions in a single bale.

That moisture variability results in a cascade of biomass processing challenges. While grinding dry bales requires less energy and tends to result in smaller average particle sizes, wet material is more difficult. A two-fold increase in moisture content can result in a four-fold increase in grinding energy while production rates drop.

After grinding, high moisture content biomass and the resulting larger average particle sizes can result in poor flowability, causing plugged conveyors and other feed handling problems.

Particle size distribution continues to play a role during conversion, where small particles are easily overcooked and large particles are undercooked.

ALL OF THESE CHALLENGES RESULT FROM JUST ONE TYPE OF BIOMASS VARIABILITY: MOISTURE CONTENT.

All of these challenges result from just one type of biomass variability: moisture content. Moisture content and particle size are just two biomass variables that can have big impacts on downstream processing and conversion efficiencies. Carbohydrate and ash composition, bulk density, and particle shape all impact feedstock performance at various steps from harvest to conversion.

The solution is complex and will likely involve a mixture of feedstock formulation, novel storage techniques, preprocessing, quality control and other technological advancements.

But none of these advancements happen without information.

Biomass Feedstock National User Facility (BFNUF) researchers have developed the Bioenergy Feedstock Library to provide exactly that — information describing the chemical and physical properties of different types and fractions of biomass. As the library grows, so does its ability to help researchers and industry solve feedstock variability challenges.

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LIBRARY HOSTS SUN GRANT PARTNERSHIP DATA

Investigators participating in a nationwide biomass feedstock research effort have stored data from thousands of feedstock samples in the Bioenergy Feedstock Library. bioenergylibrary.inl.gov/

BFNUF researchers characterized more than 4,000 feedstock samples for researchers affiliated with the Sun Grant and the Department of Energy (DOE) Regional Biomass Feedstock Partnership. The Sun Grant Initiative and DOE formed the partnership with more than 40 different research institutions to help realize the vision of a sustainable, reliable, billion-ton U.S. bioenergy industry by the year 2030.

Researchers from the partnership recently released data for nearly 2,800 of those biomass samples through the library's research tools. These tools allow public access to Sun Grant Partnership datasets in aggregate while maintaining the security of specific sample information that partners choose to keep private.

Danielle Wilson, a researcher at Iowa State University, is one Sun Grant partner who has used the library to store her sample data. Wilson, who studies perennial grasses and nutrient cycling for bioenergy crops, is part of a switchgrass group under the partnership.

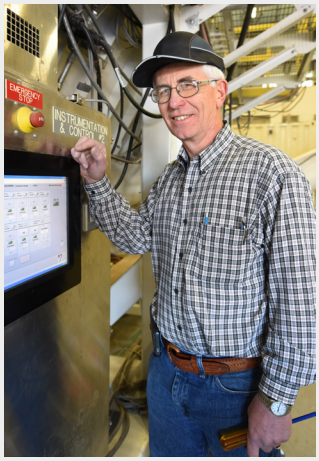
"Our interest in the library became apparent when we decided to do more studies on these crops," Wilson said. "We don't want to collect data that has already been collected over and over again. We would also like to have a framework where other people can add their data."

Wilson said her hope is that the library will enable researchers to "start asking more informed questions."

"I think it's important for a lot of researchers to have something like this," Wilson said. "We need to keep information sensitive before publication, but also make it available for the broader community later." ●

FROM SLIDE RULES TO ROBOT WELDERS:

After 38 years, engineer leaves his mark on Idaho National Laboratory



BFNUF electrical engineer Rodney Shurtliff will retire this spring after 38 years working on projects ranging from robotic radioactive waste disposal systems to bioenergy preprocessing plants.

Shurtliff began at INL designing instrumentation and control systems for analytical chemistry research at the Idaho Nuclear Technology and Engineering Center (INTEC).

After 16 years at INTEC, he moved on to help design a number of innovative radioactive waste testing and handling systems.

Most recently, Shurtliff helped develop the Process Demonstration Unit (PDU) at DOE's BFNUF. The PDU is a full-scale biomass preprocessing plant designed to help industry during process design and scale up of bioenergy plants. Shurtliff is responsible for power, control and instrumentation of the PDU system.

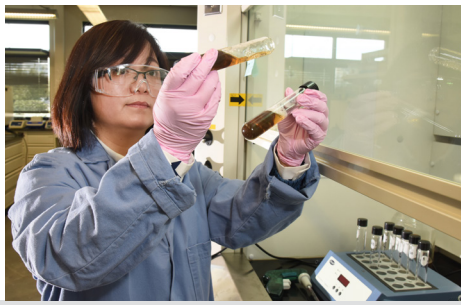
Shurtliff and his colleagues are now working to add an adaptive control system to the PDU. The system would automatically adjust its various components — conveyor speed or grinder power, for instance — to compensate for factors such as material moisture, flowability, and particle size, reducing or eliminating feed handling problems found at bioenergy plants.

Shurtliff's colleagues say his knowledge, skill and warm personality will make him hard to replace. "I can't imagine a more helpful, congenial and talented person," said David Pace, BFNUF Chief Engineer.

"Rod is a testament to the world-class talent available at Idaho National Laboratory," BFNUF director Kevin Kenney said.

After retirement, Shurtliff plans to concentrate on his small side business renovating and selling houses, and he plans to continue electrical engineering as well. ●



THE BIOENERGY FEEDSTOCK LIBRARY: FROM SAMPLE REPOSITORY TO GLOBAL RESEARCH TOOL

Idaho National Laboratory researchers created the Bioenergy Feedstock Library in 2009 to keep track of the thousands of biomass feedstock samples produced during the course of their projects.

In addition to physical feedstock samples, researchers began compiling biomass characteristics, such as ash content or composition, in a digital database. The library is fast becoming the most comprehensive, actively managed database of its kind.

Now the library is taking another leap forward and turning into a global research and development tool. The library is a living archive — continuously upgraded with new tools and feedstock samples — designed to help researchers and industry evaluate feedstock quality characteristics and formulation.

The library provides:

- Data for more than 50,000 biomass samples
- Bioenergy characterization data for more than 7,500 samples
- More than 35,000 physical biomass samples

Samples and data represent 90 different crop types, 38 states and well over 100 government, industry and academic institutions. Physical samples come from projects funded by DOE's Bioenergy Technologies Office and other contributors. bioenergylibrary.inl.gov/

BIOENERGY FEEDSTOCK LIBRARY TOOLS AND CAPABILITIES

Remote Project Management — provides outside researchers with tools to securely manage their own biomass samples and data from anywhere.

- Bar code and database management interfaces allow researchers to upload, store, edit and track samples, sample metadata and analytical data.
- Security controls can limit dissemination of raw data sets, but allow external visitors snapshots of important biomass characteristics.

Parent-Child Tracking — maintains the relationship of feedstock characteristics from single-source materials and their process intermediates in a hierarchical format through preprocessing and conversion testing. Parent-child tracking allows researchers to build upon previous analyses and relate their results to the parent sample.

Research Tools

- The Analysis Summary tool displays averages of all analyses performed for each crop type. This allows users to see the breadth of analysis types and feedstocks at a glance.
- Attribute Graphs show the characteristics of various crop types. Users enter the crop type and the analysis type for the desired graph, allowing a look at the variability of results for a given crop type(s).
- The Blend Prediction tool allows users to evaluate projected characteristics of custom biomass blends by combining characteristics of individual crops.
- The Least-Cost Formulation tool is a mapping interface that allows users to explore the regional distribution and availability of biomass crops and blends based on cost per ton, harvest radius and harvest year.

Reference Materials — commercially harvested, well characterized industrial feedstocks for researchers.

Data sheets for each sample provide details about:

- Age
- Site of origin
- Preparation
- Chemical composition
- Fuel properties
- Ash composition
- Particle characteristics

Researchers may request shipment of these reference materials.

Funding and Support

The Bioenergy Feedstock Library is part of the BFNUF, a DOE Office of Energy Efficiency & Renewable Energy facility managed at INL and sponsored by DOE's Bioenergy Technologies Office.

FOR MORE INFORMATION

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SOLVING TODAY'S FEEDSTOCK CHALLENGES, ENGAGING INDUSTRY IN SOLUTIONS FOR TOMORROW

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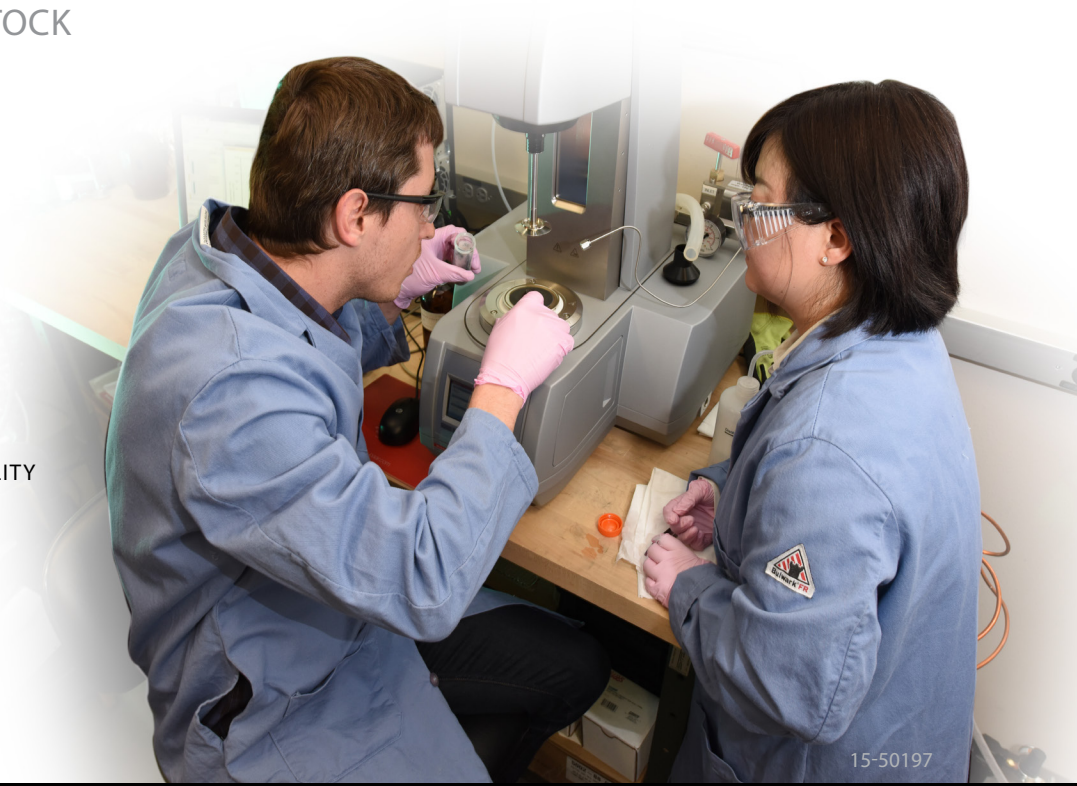

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